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Education, Risk and Efficiency in Human Capital Investment

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The efficiency of the process of investment in human capital through education is of considerable importance both to the individuals involved and to the wider economy. The paper develops an analytical framework in which issues of the efficiency of such investment can be considered alongside its interface with the operations of the labour market, and in which the risks posed by such educational investments when the labour market is less than fully efficient can be analysed. These issues are of particular relevance in the context of the major expansions in higher education which have taken place in recent years, not least in China, which is now second in its share of all 25 – 64 year olds internationally with tertiary education. The paper therefore complements its theoretical analysis with an empirical investigation of the risk factors which impact on the efficiency of this large-scale educational investment for individual graduates and for the wider economy.*

***JEL:** I21, I25, I28, J24, J31/ **KEY WORDS:** Human capital investment**,** higher education, graduate overeducation, risk factors, educational expansion in China.

I. Introduction

The key role of education in the economy is emphasised both by the large potential benefits it may bring in enhancing the productive capabilities of human capital, and by the significant costs of time and other scarce resources which are invested in the educational process. The efficiency of this process in ensuring that the benefits of education outweigh its costs is of considerable importance both to the economy at large and to the many individuals who make personal investments of time and other inputs into seeking to gain from the educational system. Questions of the efficiency of the educational process are in particular raised by the major expansion in recent years of the higher education sectors of many countries. As a percentage of the relevant age group, across the OECD as a whole for tertiary-type 5A degree programmes (i.e. those at Bachelor and Master's level with a mainly theoretical content), entry rates have increased from 37 per cent in 1995 to 59 per cent in 2009, and graduation rates from 20 per cent to 38 per cent. Within the OECD averages there has also been considerable variation across individual countries, with the United States only increasing its corresponding graduation rate from 33 per cent in 1995 to 38 per over the same period, and the Slovak Republic its graduation rate from 15 per cent to 61 per cent (OECD [2011]).

There have also been major expansions in higher education outside the OECD, with the total number of graduates from China's higher education system increasing by 594.8 per cent over the period 1997–2010, as we discuss in more detail in Section V below. Although China's 5 percentage of its own adult population that have received tertiary education is still much lower than the OECD's average of 30 per cent of its 25–64 age group who have received tertiary education, multiplication by China's own population size means that by 2009 China had 31.1 million individuals in the 25–64 age group who have received tertiary education. This places it second internationally, at 12.1 per cent, across all OECD and G20 countries in its share of the total 25–64 age group within all these countries who have received tertiary education (OECD [2011], p. 35). The expansion of higher education therefore has important implications also for the relative endowment of human capital across the international economy, with China's share of those with tertiary education now greater than Japan's 11.4 per cent share, that is in turn well ahead of the United Kingdom's 4.7 per cent share, Germany's 4.6 per cent share, Korea's 4.3 per cent share and France's 3.6 per cent share, and second only to the United States' 25.8 per cent share (*ibid*, p. 35).

The OECD itself estimates significant positive internal rates of return on the considerable direct and indirect costs which the expansion of higher education has involved. From the viewpoint of the individual undertaking the additional education, the internal rate of return on their own investment is calculated at 12.4 per cent for a man and 11.5 per cent for a woman on average across the OECD ([2011], p. 174). From the viewpoint of the public costs and benefits of an individual undertaking tertiary education, the internal rate of return is calculated at 11.1 per cent for a man and 9.2 per cent for a woman on average across the OECD (*ibid*, p. 175). However, these averages conceal important additional efficiency issues concerning the balance between the marginal costs and benefits of additional education being undertaken by more individuals, and the extent to which private and social interests are aligned in this process. Moreover, greater recognition needs to be given to the risk dimensions which such a process of increased human capital investment entails, both for the individual and for the economy as a whole. We will examine several of these additional issues in this paper, firstly from an analytical point of view and secondly in the context of an empirical application to the major emerging economy of China, which as noted above has undergone a large expansion of its higher education system in recent years.

II. Education and the Labour Market

Human capital theory, as developed by BECKER [1993] and MINCER [1974], concentrates on the supply side of the labour market, with wages determined by the assumption that a constant rate of return on investment in years of education will be earned with certainty. However, in view of the substantial changes occurring both within the higher education sector of many countries, and the wider international economy and domestic employment markets, we need a framework of analysis that can take on board changes in both the supply of more educated individuals, and the demand for their labour services, over time. We therefore examine in this paper a model of the interaction between the labour market demand for individuals with differing levels of education and the supply of such individuals that can also address the assignment problem (SATTINGER [1993]) of how individuals with different educational and other characteristics are assigned to different jobs within the labour market. Such a focus also enables us to analyse a number of important issues related to the efficiency of the interface between the education sector and the labour market.

Within this model, which we will label as M1, the demand for educated individuals is a derived demand by employers in need of skills and other characteristics that can complement the specifications of the jobs they are seeking to fill. Each job $j \in \Omega_t$ within the set Ω_t of all available jobs at time t is assumed to have a list of job specifications at time t given by the vector

$b_{jt} = (b_{j1t},...,b_{jn_2t})$, which specifies the work which the job entails. How well that job is carried out depends upon the skills and other characteristics of the individual who occupies the post associated with the job, with each individual i assumed to possess a vector of characteristics $c_{it} \equiv (c_{i1t},...,c_{in_3t})$ at time t that includes their educational background. The value of the output from the job will depend also upon the demand in the product market for the output of goods or services which the job produces. The main drivers of the level of demand at time t for such output across all jobs for whom graduates may be candidates include economy-wide factors $m_t \equiv (m_{1t},...,m_{n_1t})$, such as the level of the country's GDP, its foreign exchange rates with its major trading partners, and its population size.

More specifically, we will assume that if individual i occupies job j at time t the value of their output is given by the Cobb-Douglas function:

$$V_{ijt} = A_t \prod_{k=1}^{n_1} m_{kt}^{\alpha_k} \prod_{\ell=1}^{n_2} b_{j\ell t}^{\beta_\ell} \prod_{h=1}^{n_3} c_{iht}^{\gamma_h} \tag{1}$$

where the α_k, β_ℓ, and γ_h are positive constants and A_t is a parameter that reflects the general state of technological progress in the country concerned. The value at time t of an individual having acquired additional education therefore depends here both upon the macro-economic variables that enter into the vector m_t and upon the job to which they are assigned via the operation of the labour market. On the demand side of the labour market, the employer for any given job j is assumed to select the individual i who will occupy the post according to the individual's characteristics c_{it} in order to maximise the net value V_{ijt} - w_{it} to the employer of having such an individual perform job j, where w_{it} is the wage rate that the employer must pay individual i at time t. Since for each $j = 1,...,n_2$, the individual characteristics c_{iht} influence V_{ijt} in (1) via the index

$$H_{it} \equiv \prod_{h=1}^{n_3} c_{iht}^{\gamma_h} \quad with \quad \partial V_{ijt} / \partial H_{it} > 0 \tag{2}$$

employers will evaluate each individual according to their overall value of H_{it}. In our initial Model M1, in which we assume a competitive labour market with flexible wages, employers are willing to offer a higher wage to individuals whose overall value of H_{it} is greater. For each small increase in H_{it}, the employer for job j would be willing to pay an additional wage premium up to an amount equal to $\partial V_{ijt} / \partial H_{it}$. In a competitive labour market with flexible wages, the wage w_{it} will then be bid up to be an increasing function of H_{it}, with

$$(\partial w_{it} / \partial H_{it}) = (\partial V_{ijt} / \partial H_{it}) = \theta_t S_{jt} \ where\ \theta_t \equiv A_t \prod_{k=1}^{n_1} m_{kt}^{\alpha_k},\ S_{jt} \equiv \prod_{s=1}^{n_2} b_{jst}^{\beta_h} \qquad (3)$$

for the job j which individual i performs. Moreover, since $(\partial^2 V_{ijt} / \partial H_{it} \partial S_{jt}) > 0$ employers with jobs whose specification level is higher according to the index S_{jt} will be willing to offer a greater additional premium to individuals who possess superior characteristics according to the index H_{it} than employers with jobs whose specification level is lower according to the index S_{jt}. In such a competitive labour market, employers with jobs whose specification level is higher according to the index S_{jt} will succeed in recruiting individuals with superior characteristics according to the index H_{it}. The top n individuals according to the index of individual characteristics H_{it} are then recruited to the top n jobs according to the index S_{jt} of job specifications for all $0 < n < \eta_t$, where η_t is the total number of jobs in the economy at time t. We will assume for simplicity that the total number of jobs, including those in subsistence agriculture, at each time t is equal to the number of individuals of working age, with all individuals assumed to have access to at least a subsistence job.

Across the population as a whole of individuals of working age, we will assume that the individual characteristics $c_{i1t},...,c_{in_3t}$ are distributed according to a multivariate lognormal density function, with a resultant lognormal cumulative distribution function, F_t, at time t for the index H_{it} across this population (see AITCHISON and BROWN [1963], p.12). Similarly across the population of available jobs within the economy, we will assume that the job specifications $b_{j1t},...,b_{jn_2t}$ are distributed according to a multivariate lognormal density function that results in a lognormal cumulative distribution function, Φ_t, at time t for the index S_{jt} across all available jobs in the economy. We then have:

$$F_t(H_{it}) = \Phi_t(S_{jt}(H_{it}))\ for\ all\ H_{it} > 0\ \ and\ hence\ S_{jt}(H_{it}) = \Phi_t^{-1}(F_t(H_{it})) \qquad (4)$$

where $S_{jt}(H_{it})$ is the level of specification for the job to which an individual with a level of characteristics H_{it} is recruited. (4) in turn implies:

$$S_{jt}(H_{it}) = H_{it}^{\sigma_{St}/\sigma_{Ht}} Z_t \ \ where\ Z_t \equiv \exp(\mu_{St} - \mu_{Ht}(\sigma_{St}/\sigma_{Ht})) \tag{5}$$

where μ_{St} and μ_{Ht} are the mean values of $\ln S_{jt}$ and $\ln H_{it}$, and σ_{St} and σ_{Ht} are their respective standard deviations, at time t across their respective populations of jobs and individuals within the economy.

Equations (2), (3) and (5) imply a wage function of the form:

$$w_{it} = \psi_t \prod_{h=1}^{n_3} c_{iht}^{a_{ht}} + \varsigma_t \ \ where\ \ a_{ht} \equiv \ \gamma_h \xi_t,\ \ \xi_t \equiv 1 + (\sigma_{St}/\sigma_{Ht}), \psi_t \equiv \ \theta_t Z_t / \xi_t \tag{6}$$

where ς_t is a constant of integration, which can be shown to be proportional to the reservation wage given by the unemployment benefit rate if jobs offering a subsistence wage are available to all. If $\varsigma_t = 0$, equations (1), (2), (3), (5) and (6) imply:

$$V_{ijt} = \theta_t Z_t H_{it}^{\xi_t} \ \ \&\ \ V_{ijt} - w_{it} = \sigma_{St}\theta_t Z_t H_{it}^{\xi_t} / (\sigma_{St} + \sigma_{Ht}) > 0 \ \ for\ all\ H_{it} > 0 \tag{7}$$

so that wage levels still enable employers to make a net surplus from the jobs they offer. Equations (3), (5) and (6) also imply that:

$$\ln(w_{it} - \varsigma_t) = a_{ot} + \xi_t \sum_{h=1}^{n_3} \gamma_h \ln c_{iht} \ \ where\ \ a_{ot} \equiv \sum_{k=1}^{n_1} \alpha_k \ln m_{kt} + \ln A_t + \mu_{St} - \mu_{Ht}(\sigma_{St}/\sigma_{Ht}) - \ln \xi_t \tag{8}$$

thus providing a generalised form of lnwage function that includes allowance for a reservation wage and for the macro-economic demand-side and time-varying factors which enter into a_{ot}. It is notable also here that the elasticity of the additional wage with respect to an increase in an individual characteristic h, such as their length of education, is not simply the respective supply-side parameter γ_h of this characteristic in the underlying production function (1) but rather its product with ξ_t that, as in equation (6), reflects the relative dispersion in job characteristics and in the characteristics of the individuals who might be recruited to fill these job across the economy and the population as a whole.

Model M1 and equation (6) therefore yields a wage function of the form:

$$w_{it} = w_{it}(c_{i1t},...,c_{in_3t};\kappa_t) \quad (9)$$

where κ_t is a vector that includes the factors which enter into a_{ot}, ς_t and ξ_t, but which does not include the characteristics of the job to which the individual is recruited. Within Model M1, educational attainment and other individual characteristics within the vector c_{it} play an important part in wage determination, as in equation (9). However, so too do the parameters μ_{St} and σ_{St} of the distribution of job characteristics, alongside the parameters μ_{Ht} and σ_{Ht} of the overall distribution of individual characteristics in the population at large, as in equations (6) and (8).

Model M1 therefore differs from THUROW [1975]'s job competition model where wages are only "based on the characteristics of the job in question" (*op. cit* p. 76) and "not directly on ... personal characteristics" (*ibid*, p. 77). In Thurow's model, marginal productivity is taken as a fixed characteristic of the job, but wages do not necessarily equal marginal productivity, with HARTOG and OOSTERBEEK [1988] considering that in Thurow's model "in fact, it is not at all clear how exactly earnings are determined". Within Model M1, wages are those that induce those workers who are higher in the order of desirable characteristics into the jobs whose specifications will ensure that these individual characteristics result in a higher value of output across the range of available jobs. While the parameters of the distributions of job specifications and individual characteristics both enter into the wage equation (6), they remain constant across the same labour market at any given point in time. We can then contrast the above Model M1 with a more general specification of the cross-sectional wage function in which details of the job specification, as reflected in the index S_{jt}, also enter into the wage function, so that under this alternative Model M2 we have in contrast to (9):

$$w_{ijt} = w_{ijt}(c_{i1t},...,c_{in_3t},S_{jt};\kappa_t'') \quad (10)$$

where κ_t'' is a vector of macro-economic and other time-varying factors that may, or may not, be identical to κ_t.

III. Efficiency in Human Capital Investment in Education

In the context of Model M1, we may characterise individuals as making decisions on their desired length of education, T_i, by seeking to maximise their life-time utility U_i (using a subjective time preference rate υ_i) over Q_i years of life, subject to an inter-temporal budget constraint that the present value of their life-time consumption is equal to the present value of their wage income less the present value of their tuition fees, i.e.

$$\max_{T_i} U_i = \int_0^{Q_i} U_i(C_{it}) e^{-\upsilon_i t} dt \quad s.t. \int_0^{Q_i} C_{it} e^{-rt} dt = -\int_0^{T_i} \tau_{it} e^{-rt} dt + \int_{T_i}^{R_i} w_{it} e^{-rt} dt \tag{11}$$

where C_{it} is individual i's consumption level at time t, r is the prevailing interest rate, τ_{it} is the level of their tuition fees at time t, and R_i is their retirement age. Wage income w_{it} earned during the individual's working life after leaving full-time education at time $t = T_i$ up until retirement at time $t = R_i$ must provide a return on the individual's investment in education that is sufficient to finance their life-time consumption. Included here is their consumption in retirement that is funded through their savings and pension contributions out of their wage income whilst working. This aspect of individual life-time finances has taken on an increased importance in view of recent policy concerns over the need to adjust retirement ages to improve the funding of pension schemes (e.g. PENSIONS COMMISSION [2006]) in the face of rising life expectancy and increasing financial problems for both public and private pension schemes. We will therefore consider a number of possibilities for the extent to which the retirement age R_i can be responsive to T_i, through considering the relationship:

$$R_i = R_0 + \omega T_i \quad where \quad R_i > T_i \tag{12}$$

The case $\omega = 0$ corresponds to the case where there is a fixed retirement age R_0 irrespective of how long the individual has spent in full-time education. The case $\omega = 1$ in contrast corresponds to the case where individuals work $R_0 = R_i - T_i$ years to finance their retirement, irrespective of how long they have spent in full-time education. By explicitly considering a finite working life, we are also able to relax any requirement in (11) that the (real) interest rate r is greater than the rate of growth in (real) wages, with this requirement potentially unrealistic in some emerging economies, such as China, where annual growth rates in real GDP per capita have significantly exceeded the prevailing real interest rate.

For analytical simplicity, we will assume in this section that the wages w_{it} of each individual during their working life are influenced by their length of schooling, T_i, by their length of working experience $t - T_i$ at time t, and by the $n_3 - 2$ other individual characteristics that do not change over time, with:

$$c_{i1t} = T_i \quad and \quad c_{i2t} = \exp(t - T_i) \quad for \quad t \geq T_i \tag{13}$$

in the wage function (6) for Model M1. Over time $t \geq 0$, the index θ_t of macroeconomic variables is assumed grow at the exponential rate g_θ, where θ_t includes the parameter A_t that reflects the general state of technological progress in the economy as in equation (3). At the same time, the mean level μ_{St} of the log of the job specifications index S_{jt} across the available jobs j in the economy is assumed to increase by g_S per unit of time $t \geq 0$. The expansion rate in education is characterised here by the parameter g_T, that corresponds to the increase per unit time in the mean level of $\ln T_i$ across individuals. While the mean levels of these variables are increasing over time, for the sake of simplicity we will assume a zero reservation wage, so that $\varsigma_t = 0$, and that the variances of $\ln S_{jt}$ and $\ln H_{it}$ remain constant, with:

$$\sigma_{St} = \sigma_S, \sigma_{Ht} = \sigma_H, \sigma \equiv \sigma_S / \sigma_H \quad for\ all\ t \geq 0 \tag{14}$$

Equations (5), (6), (13) and (14) then imply:

$$w_{it} = w_{i0} \exp(\hat{g}t + \gamma_2(1+\sigma)(t - T_i)) \quad for\ t \geq T_i \quad where \quad \hat{g} = g_\theta + g_S - \gamma_2\sigma - (\gamma_1 - \gamma_2) g_T \sigma \tag{15}$$

so that while *ceteris paribus* the growth rate in wages over time is boosted by the growth rate g_θ in the macro-economic index θ_t and by the growth rate g_S in job specifications, it is depressed here by a higher growth rate g_T in the mean length of education in the population at large, whenever the coefficient γ_1 on the length of education in the production function exceeds the coefficient γ_2 on work experience, to an extent that depends upon the parameter σ that reflects the relative dispersion of job specifications and of individual characteristics in the economy.

When equation (15) is inserted into (11), the first-order conditions for (11) imply that individual i's desired length of education is given by:

$$T_i^* = \gamma_1(1+\sigma)W_{iT_i^*} / (\tau_{iT_i^*} + w_{iT_i^*} - \omega w_{iT_i^*}Y_i + \gamma_2(1+\sigma)W_{iT_i^*}) \quad for \ W_{iT_i^*} \equiv w_{iT_i^*}\Psi_i \tag{16}$$

$$= \gamma_1(1+\sigma) / ((\vartheta_i + 1 - \omega Y_i)\Psi_i^{-1} + \gamma_2(1+\sigma)) \ \ where \ Y_i \equiv \exp(g-r)(R_i - T_i^*), \tag{17}$$

$$\Psi_i \equiv (1-Y_i)/(r-g) > 0, g \equiv \hat{g} + \gamma_2(1+\sigma), \vartheta_i \equiv \tau_{iT_i^*} / w_{iT_i^*}, \ and \ \partial\Psi_i / \partial g > 0$$

$W_{iT_i^*}$ is here the present value, at time $t = T_i^*$, of individual i's future wages after completing T_i^* years of education, when the growth rate in wages is g. The elasticity of the graduation wages with respect to increases in individual i's length of education from (6) and (14) is $\gamma_1(1+\sigma)$. Equation (16) can then be shown to ensure that the marginal benefit to individual i from increasing their length of education, in terms of an increased present value of their future earnings once they graduate, is equated to the marginal cost of the additional education to individual i, as reflected in the denominator of equation (16). This is equal to the tuition costs they bear for the additional education, plus the opportunity cost of the wages they forego by not entering the labour market sooner, minus the present value of any additional wages they will earn by extending their retirement date as a result of their increased education, and plus the impact on the present value of their lifetime earnings from the reduction in the years of work experience which increased education implies. We will assume here that $\omega Y_i < \vartheta_i + 1$.

Differentiation of equations (16) and (17) implies that:

$$\partial T_i^* / \partial g > 0, \partial T_i^* / \partial \omega > 0, \partial T_i^* / \partial \vartheta_i < 0, \partial T_i^* / \partial r < 0, \partial T_i^* / \partial \sigma (>,=,<) \ 0 \ as \ T_i^* (<,=,>) \ T_i' \tag{18}$$

$$\partial T_i^* / \partial \gamma_1 (>,=,<) \ 0 \ as \ g_T (<,=,>) \ g_T' \equiv 1/(\sigma\gamma_1\zeta_i), \partial T_i^* / \partial \gamma_2 (>,=,<) \ 0 \ as \ T_i^* (<,=,>) \ T_i'' \tag{19}$$

$$where \ T_i' \equiv (\gamma_1/\gamma_2)[1 + \zeta_i(1+\sigma)(\gamma_2(1+g_T) - \gamma_1)], \ \zeta_i \equiv ((\partial T_i^* / \partial g)/T_i^*) > 0, T_i'' \equiv \zeta_i\gamma_1(\sigma(1+g_T)+1)$$

so that individual i's desired length of education is an increasing function of the growth rate g in wages, and of the extent to which the retirement date increases with the length of education. Once the working life is finite and $\omega \neq 0$, the opportunity cost of longer education is not simply the current wage which the individual could earn by working rather than opting for more education, as in MINCER [1974]. Rather it includes an offsetting factor in (16) of the present value of the additional wages the individual could earn by deferring their retirement age following their increased education if $\omega > 0$, or an additional opportunity cost if $\omega < 0$ of the present value of the future wages that the individual foregoes by retiring earlier as a result of their additional education.

The individual's desired length of education, T_i^*, in (18) is also a decreasing function of the interest rate r and of the ratio ϑ_i between the tuition fee and the current wage. A variation in ϑ_i across individuals will itself produce variations in the desired length of education across different individuals. *Ceteris paribus*, high ability individuals who face low tuition fees, net of scholarships, compared to their foregone wage will have a higher desired length of education compared to those of lower ability individuals, who may face higher tuition fees relative to their current earning power. Up to the critical value T_i', the desired length of education for individual i in (18) will also increase with increases in σ, the relative dispersion in job specifications and in individual characteristics within the economy. A lower variation across individuals in their characteristics and a higher variance across jobs in their specifications will here provide greater gains to individual i in the labour market from increased education that places them more towards the upper tail of the distribution of individual characteristics, where there is less competition from other individuals but more job opportunities with high specifications seeking more educated individuals. Since the coefficients γ_1 and γ_2 in the production function on years of education and of working experience also affect the rate of growth of wages in (15) and (17), the overall direction of the impact of these coefficients on the desired length of education of individual i in equation (19) will depend in part upon the strength of the impact of the growth rate in wages upon T_i^*, as reflected in the parameter ζ_i in (19).

Each individual's desired length of education can now be compared to the length of education T_i^{**} which maximises the value V_{ij} of their production over their working life, net of the full cost $G_i(T_i)$ of their education. Using equations (1), (12) - (14), when the coefficients g_θ, g_S, g_T and γ_2 are held constant, the first order conditions for the associated optimisation:

$$\max_{T_i} V_{ij}^{'} = V_{ij} - G_i(T_i) \;\; where \;\; V_{ij} \equiv \int_{T_i}^{R_i} V_{ijt} e^{-rt} dt \tag{20}$$

can be shown to imply:

$$T_i^{**} = \gamma_1 / [\gamma_2 + ((1 + G_i^o - \omega Y_i^o)(r - g^o) / (1 - Y_i^o))] \tag{21}$$

where $g^o \equiv g_\theta + g_S + \gamma_2$, $Y_i^o \equiv \exp((g^o - r)(R_i - T_i^{**}))$, $G_i^o \equiv (\partial G_i / \partial T_i)(e^{T_i r} / V_{ijT_i})$ (22)

When $g_T = 0$, $g^o = g$ from (17) and (22). If $G_i^o \geq \vartheta_i$, (17) and (21) then imply:

$$T_i^* > T_i^{**} \tag{23}$$

so that under the above assumptions individuals' desired levels of education exceed those that maximise the value of their own production, net of the full costs of their tuition, and in this sense individuals are willing to be inefficiently overeducated. The extent of this divergence can be shown from equations (17) and (21) to increase with the relative degree σ of dispersion between job specifications and individual characteristics, which, as noted above, provides the individual with more gains from *differentiation* from others in the level of their education in the search for a higher level job. From equations (17) and (21), the extent of the divergence in (23) will also be increased if individuals are *misinformed* about the actual growth rate in future wages, and over-optimistically believe the value of g upon which they make their educational investment decisions to be greater than the actual economic growth rate g^o. Such may indeed occur if the macro-economic variables in (1) unexpectedly deteriorate through a slow-down in international economic growth, or if there are remaining gains to be had from improving the quality of the careers advice which individuals receive in making their educational investment decisions (see MAYSTON [2002]).

Model M1 differs in several respects from signalling theory (e.g. SPENCE [1973]), where individuals have an incentive to invest, and over-invest, in education when their educational level is used as a *signal* to convey information to their potential employers about their future productivity, even though the education may not itself directly raise their productivity. As SPENCE [1973] noted, 'Systematic overinvestment in education is a distinct possibility because of the element of arbitrariness in the equilibrium configuration of the market', with education potentially an arbitrary choice as the signal for higher productivity within signalling theory. However, within Model M1, increased education in contrast does raise each individual's output, but still has a limited number of graduate-level jobs available in the economy at any given time.

IV. The Risk of Overeducation

Since from equation (5) for any job j for which individual i is selected $\partial S_{jt} / \partial H_{it} > 0$, under Model M1 individuals secure a higher specification job according to the index S_{jt} if they obtain a higher rating according to their overall quality given by the linear function:

$$q_{it} \equiv \ln H_{it} = \sum_{h=1}^{n_3} \gamma_h x_{iht} \ where \ x_{iht} \equiv \ln c_{iht} \tag{24}$$

However, we may again consider Model M1 as a special case of a more general process by which individuals with different educational and other characteristics are allocated to jobs with different specifications. We will therefore consider within the context of our Model M2 the selection of individuals to jobs according to a linear function in which the coefficients γ_h in (24) are replaced by logarithmic weights $\hat{\gamma}_h$ on the individual characteristics which are not necessarily equal to the coefficients γ_h in the underlying production function (1), and we introduce an element of uncertainty into the process of selection for higher-level jobs. In place of equation (5), in Model M2 we will therefore assume that individual i secures a job of specification S_{it} at time t according to the selection rule:

$$S_{jt}(\hat{H}_{it}) = \hat{H}_{it}^{\sigma_{St}/\sigma_{\hat{H}t}} \hat{Z}_t \ where \ \hat{H}_{it} \equiv \varepsilon_{it} \prod_{h=1}^{n_3} c_{iht}^{\hat{\gamma}_h} \ and \ \hat{Z}_t \equiv \exp(\mu_{St} - \mu_{\hat{H}t}(\sigma_{St} / \sigma_{\hat{H}t})) \tag{25}$$

where ε_{it} is a stochastic term whose log is normally distributed with zero mean and unit variance independently of $x_{it} \equiv (x_{i1t}, ..., x_{in_3t})$, and $\mu_{\hat{H}t}$ and $\sigma_{\hat{H}t}$ are the mean and standard deviation of the resultant normal distribution of $\ln \hat{H}_{it}$ across the population of individuals of working age. In particular, in order to secure a job of level $\ell > 0$ or above, individual i must have a quality level under Model M2 of

$$\hat{q}_{it} > \hat{q}_t^{o\ell} \equiv (\sigma_{\hat{H}t} / \sigma_{St})(\ln S_t^{o\ell} - \mu_{St}) + \mu_{\hat{H}t} \ where \ \hat{q}_{it} \equiv \ln \hat{H}_{it} \tag{26}$$

and where $S_t^{o\ell}$ denotes the minimum level of the job specifications index S_{jt} for which skills of level ℓ are required to perform the tasks which the job involves, and below which only a lower level of skills is required.

Employers thus set a 'hurdle' level $\hat{q}_t^{o\ell}$ at time t for the minimum assessed quality $\hat{q}_{it}$ of individual i to whom an offer is made of a level $\ell > 0$ job. The total supply of individuals who satisfy the minimum level of quality of $\hat{q}_t^{o\ell}$ is given by:

$$L_t(\hat{q}_t^{o\ell}) = \eta_t(1 - N((\hat{q}_t^{o\ell} - \mu_{\hat{H}t}) / \sigma_{\hat{H}t})) \ \ with \ \partial L_t / \partial \hat{q}_t^{o\ell} < 0 \tag{27}$$

$$= \eta_t(1 - N((\ln S_t^{o\ell} - \mu_{St}) / \sigma_{St})) = \eta_t(1 - \Phi_t(S_t^{o\ell})) = D_t(S_t^{o\ell}) \ with \ \partial D_t / \partial S_t^{o\ell} < 0 \tag{28}$$

using equation (25), where N is the standardised normal distribution function, and $D_t(S_t^{o\ell})$ from equation (5) is the total demand by employers at time t for individuals to fill jobs with a specification $S_t^{o\ell}$ or above. The quality hurdle therefore acts as a *non-price rationing device* to ensure that the supply of individuals who satisfy the hurdle requirements is equal to the demand by employers to fill jobs with at least this specification.

The hurdle level $\hat{q}_t^{o\ell}$ in equation (26) depends upon the parameters of the distribution of job specifications in the economy and the distribution of individual characteristics in the population, both of which may change over time with growth in the economy at large and changes in the supply of individuals with different levels of education. An increase in the number of individuals with a higher level of education will itself tend to boost $\mu_{\hat{H}t}$ in equation (26) and hence raise the quality hurdle $\hat{q}_t^{o\ell}$ in terms of the individual characteristics that individuals require in order to be offered a job of specification level $S_t^{o\ell}$. There is therefore a distinction, once individuals have an incentive to invest in more education than the level which maximises the net value of their production, between the educational qualifications which are needed to be offered a job with a specification level $S_t^{o\ell}$ and the educational qualifications that are needed to perform in the job once it is secured. The individuals who are offered the job may then be 'overeducated' for the jobs which they are actually offered.

The probability of any individual i with objective characteristics given by x_{iT} on graduation being offered employment at level ℓ from equation (26) is given by:

$$p_{i\ell}(x_{iT}) \equiv \Pr(\hat{q}_T^{o\ell+1} > \hat{q}_{iT} > \hat{q}_T^{o\ell} \mid x_{iT}) = \Pr(\hat{q}_T^{o\ell+1} > x_{iT}\hat{\gamma} + \varepsilon_{iT}^{o} > \hat{q}_T^{o\ell}) = N(-x_{iT}\hat{\gamma} + \hat{q}_T^{o\ell+1}) - N(-x_{iT}\hat{\gamma} + \hat{q}_T^{o\ell})$$
$$= N(x_{iT}\hat{\gamma} - q_T^{o\ell}) - N(x_{iT}\hat{\gamma} - q_T^{o\ell+1}) \;\; for \;\hat{\gamma} \equiv (\hat{\gamma}_1, ..., \hat{\gamma}_{n_3})' \tag{29}$$

for $\ell = 1,...,s$ and where we set $q_T^{o1} \to -\infty$ *and* $q_T^{os+1} \to \infty$. The possibility of overeducation in both Models M1 and M2 arises from the possibility that an individual will have graduated with a qualification of level ℓ (which we will denote by $\delta_{iT\ell} = 1$) but still have an overall level of quality that falls short of the minimum hurdle level for being offered a job of level ℓ. When we include a stochastic element in the selection process, as in Model M2, the associated probability of overeducation is given by:

$$p^{o}_{i\ell}(x^{\ell}_{iT}) \equiv \Pr(\widehat{q}_{iT} < \widehat{q}^{o\ell}_{T} \,|\, x_{iT} \;\&\; \delta_{iT\ell} = 1) = \Pr(x^{\ell}_{iT}\widehat{\gamma} + \varepsilon^{o}_{iT} < \widehat{q}^{o\ell}_{t}) = N(\widehat{q}^{o\ell}_{T} - x^{\ell}_{iT}\widehat{\gamma}) \tag{30}$$

where x^{ℓ}_{iT} is a vector of individual characteristics x_{iT} that includes the individual having graduated with a qualification of level ℓ, and which act here as *risk modification factors* in reducing the risk of individual i failing to achieve a higher-level job offer. Similarly undereducation can arise in the above analysis if an individual has an overall level of quality, $\widehat{q}_{iT}$, that exceeds the minimum hurdle level, $\widehat{q}^{o\ell}_{T}$, for being offered a job of level ℓ, even though they have not graduated with a qualification of level ℓ (which we will denote by $\delta_{iT\ell} = 0$). The associated probability of undereducation is given by:

$$p^{u}_{i\ell}(x^{o\ell}_{iT}) \equiv \Pr(\widehat{q}_{iT} > \widehat{q}^{o\ell}_{T} \,|\, x_{iT} \;\&\; \delta_{iT\ell} = 0) = \Pr(x^{o\ell}_{iT}\widehat{\gamma} + \varepsilon^{o}_{iT} > \widehat{q}^{o\ell}_{T}) = N(x^{o\ell}_{iT}\widehat{\gamma} - \widehat{q}^{o\ell}_{T}) \tag{31}$$

where $x^{o\ell}_{iT}$ is a vector of individual characteristics x_{iT} that includes the individual having graduated without a qualification of level ℓ. Equation (29) enables us to empirically estimate the coefficient vector $\widehat{\gamma}$ on the individual characteristics and the hurdle levels $\widehat{q}^{o\ell}_{T}$ that influence the probability of over- and undereducation in equations (30) and (31), through the use of an *ordered probit* analysis (see CAMERON and TRIVEDI [2005], p. 520), whose results we examine in Section V.2 below.

In the absence of a forward market in job contracts, the individual must now decide on their desired length of education in advance of entering the labour market and in the face of *risk and uncertainty* as to the level of the job they will be offered on graduation, which under Model M2 influences their graduation wage. In the context of Model M2, we can characterise individuals as making decisions on their desired length of education, T_i, by seeking to maximise their expected life-time utility, subject to a lifetime budget constraint holding for each level $\ell = 1,...,s$ of the job specification index S_{jt} that enters into the wage function, i.e.

$$\max_{T_i} E(U_i) = \sum_{\ell=1}^{s} p_{i\ell} \int_0^{Q_i} U_i(C_{it\ell}) e^{-\upsilon_i t} dt \quad s.t. \int_0^{Q_i} C_{it\ell} e^{-rt} dt = -\int_0^{T_i} \tau_{it} e^{-rt} dt + \int_{T_i}^{R_i} w_{it\ell} e^{-rt} dt \quad for \;\; \ell = 1,..,s \tag{32}$$

where $w_{it\ell}$ is the wage at time t that individual i will be paid if they do secure a job at level ℓ, and $C_{it\ell}$ is the individual's consumption level at time t if this occurs. If the growth rate, g, in wages is independent of ℓ, (32) implies that the individual's desired length of education is now given by:

$$T_{i2}^{*} = \gamma_1(1+\sigma)/((\vartheta_{i2} - \phi_i + 1 - \omega Y_{i2})\Psi_{i2}^{-1} + \gamma_2(1+\sigma)) \; where \; \vartheta_{i2} \equiv \tau_{iT_{i2}^{*}} \sum_{\ell=1}^{s} \lambda_{i\ell} / \chi_i , \chi_i \equiv \sum_{\ell=1}^{s} \lambda_{i\ell} w_{iT_{i2}^{*}\ell} \tag{33}$$

$$and \; \phi_i \equiv e^{rT_{i2}^{*}} \sum_{\ell=1}^{s} (\partial p_{i\ell} / \partial T_i) \int_0^{Q_i} U_i(C_{it\ell}) e^{-\upsilon_i t} dt / \chi_i , \Psi_{i2} \equiv (1 - Y_{i2})/(r-g), Y_{i2} \equiv \exp(g-r)(R_i - T_{i2}^{*})$$

$\lambda_{i\ell} > 0$ is here the Lagrangean multiplier associated with the inter-temporal budget constraint in (32) that prevails if individual i does secure a job with specification level ℓ. ϑ_{i2} is the ratio between the level of the tuition fee facing individual i and a weighted sum of the wages the individual would be paid in each of the different job specification levels that enter the wage function. In contrast to T_i^{*} in (17) under Model M1, there is now an additional term ϕ_i in the denominator of T_{i2}^{*} in (33), which *ceteris paribus* tends to increase the individual's desired level of education whenever $\phi_i > 0$. Such will occur whenever more education for individual i boosts their probability of securing a job with a higher level of specification that in turn increases their lifetime earnings and associated utility level. From equations (29) and (33) we have in particular that:

$$\phi_i = \hat{\gamma}_1 [e^{rT_{i2}^{*}} \sum_{\ell=2}^{s} \varphi(x_{iT}\hat{\gamma} - q_T^{o\ell}) \, \Delta U_{i\ell} / (\chi_i T_i)] \; where \; \Delta U_{i\ell} \equiv \int_0^{Q_i} [U_i(C_{it\ell}) - U_i(C_{it\ell-1})] e^{-\upsilon_i t} dt \tag{34}$$

where φ is the standardised normal density function and $\Delta U_{i\ell}$ is the increased lifetime utility which individual i achieves by securing a job of level ℓ rather than a job of level $\ell - 1$, with associated increased wages in Model M2. For $\Delta U_{i\ell} > 0$, ϕ_i is an increasing function of the coefficients $\hat{\gamma}_h$ in the selection process given by equation (25). ϕ_i, and hence T_{i2}^{*} in equation (33), are also increasing functions of each $\Delta U_{i\ell}$ for $\ell = 2,...,s$ and a decreasing function of $U_i(C_{it1})$, so that macro-economic changes, such as slower economic growth and rising unemployment risks which may impact more adversely on individuals with less education in lower-level jobs, can themselves act as a spur to increase the desired educational investment level of individual i seeking to maximise their expected utility level. However, whilst those without tertiary education have in general faced a higher risk of unemployment, as in OECD [2011], a rapid expansion of higher education will itself tend to both drive up the quality hurdle $\hat{q}_t^{o\ell}$ and level of education needed to obtain higher-level jobs in equation (26) through increasing $\mu_{\hat{H}t}$, and at the same time depress their wages in equations (8) - (10) and associated additional utility payoff in equation (34), making the risk calculation for greater investment in education a more finely balanced one.

For the case where $g_T = 0$, $\vartheta_{i2} \leq \vartheta_i$ and either $\omega = 1$ or $Q_i \to \infty$ and $R_i \to \infty$, we have from (12), (17) and (33):

$$T_{i2}^* > T_i^* \qquad (35)$$

so that the incentive for individuals to over-invest in education is even greater here under Model M2 than under Model M1. However, this result is less clear-cut when we relax the assumption of either an infinite working life or a fixed finite total working life, such as occurs when $\omega = 1$. Once $\omega < 1$, an increased length of education that the additional positive term ϕ_i in equation (33) under Model M2 encourages has the accompanying disbenefit of reducing the total length of the individual's working life in which to enjoy the enhanced wages that such an increased length of education promises. The overall incentive to over-invest in education is therefore less strong than in the case where $\omega = 1$, with both the magnitude and the sign of the difference between T_{i2}^* and T_i^* now dependent upon the relative strength of the terms given in the denominators of equations (17) and (33) above. Moreover, the incentive for each individual to seek to be overeducated in both equation (17) in Model M1 and in equation (33) in Model M2 (whenever $\omega Y_{i2} < \vartheta_{i2} - \phi_i + 1$) can be shown to be reduced by any expansion of the mean length of education, as reflected in a positive value to the coefficient g_T , which reduces the scarcity value of greater education and the associated overall growth rate g of wages in equations (15) and (17) whenever $\gamma_1 > \gamma_2$.

V. Empirical Application to a Major Emerging Economy

As noted in the *Introduction*, China provides an important example of a major emerging economy which has undergone a substantial expansion in the length of education of many individuals in its large population, in particular through the rapid expansion of its higher education system. This expansion is highlighted in Table I below, which shows the increases in student numbers over the period 1997 – 2010 in students entering, enrolled upon and graduating from regular university undergraduate degree, Master's degree and Doctoral programmes in China. The penultimate column of Table I shows the annual percentage increases in the total number of graduates from such programmes. The last column of Table I shows the annual percentage increases in China's

GDP at constant prices. The last row of Table I shows the overall percentage increases in the relevant student numbers, total graduates and GDP at constant prices respectively over the whole period 1997 – 2010.

Table I. - THE GROWTH RATES OF HIGHER EDUCATION AND GDP IN CHINA

	Undergraduate degrees			Master's degrees			Doctorates			% inc	% inc
Year	Entrants	Enrolment	Graduates	Entrants	Enrolment	Graduates	Entrants	Enrolment	Graduates	Grads	GDP
1997	579679	1986125	381647	50315	135702	39114	12917	39927	7319		
1998	653135	2234647	404666	57300	153110	38051	14962	45246	8957	5.5	7.8
1999	936690	2724421	440935	71847	178525	44189	19915	54038	10320	9.7	7.6
2000	1160191	3400181	495624	102923	233144	47565	25142	67293	11004	11.9	8.4
2001	1381835	4243744	567839	132762	306479	54700	32093	85885	12867	14.7	8.3
2002	1585286	5261724	655146	164269	392243	66203	38342	108737	14638	15.8	9.1
2003	1890295	6457188	919759	220200	514600	92300	48700	136700	18800	40.1	10.0
2004	2099100	7378500	1196300	273000	654300	127300	53300	165600	23500	30.7	10.1
2005	2363647	8488188	1465786	310037	787293	162051	54794	191317	27677	22.9	11.3
2006	2530854	9433395	1726674	341970	896615	219655	55955	208038	36247	19.8	12.7
2007	2820971	10243030	1995944	360590	972539	270375	58022	222508	41464	16.4	14.2
2008	2970601	11042207	2256783	386658	1046429	301066	59764	236617	43759	12.7	9.6
2009	3261081	11798511	2455359	449042	1158623	322615	61911	246319	48658	8.6	9.2
2010	3512563	12656132	2590535	474415	1279466	334613	63762	258950	48987	5.2	10.4
% inc	505.9	537.2	578.8	842.9	842.8	755.5	393.6	548.6	569.3	594.8	240.6

Sources: Ministry of Education, China [2012], and World Bank [2012]

Table I reveals annual rates of growth in the total number of graduates from the above degree programmes well in excess of the growth rate in its real GDP throughout the years 1999 – 2008. The overall increase over the period 1997 – 2010 in the total number of graduates of 594.8 per cent (i.e. to almost seven times its level in 1997) is nearly two and a half times the increase over the same period of 240.6 per cent in China's GDP at constant prices, which itself is very high by international standards. Within the increase in the total number of graduates, the number of graduates from Master's programmes increased by 755.5 per cent over the period 1997 – 2010. The increase of 436.7 per cent in total number of graduates from the above degree programmes between 2000 and 2010 is itself proportionately greater than the 342.8 per cent increase over the same period in the total output of graduating students from China's tertiary education sector as a whole, including non-university higher educational institutions and non-degree programme, which rose from 1,775,999 in 2000 to 7,863,663 in 2010 (UNESCO [2012]).

At the same time, China's transition from a centrally controlled planned economy to a greater market orientation raises interesting questions about the extent to which its labour market for its graduates from its expanding higher education system has behaved according to the competitive Model M1, in which graduation wages flexibly adjust to clear the labour market, so that individual graduates are paid no more than is necessary to induce them to take a given job, or has behaved according to our Model M2, in which there is a premium, as reflected in the ϕ_i term in equation (33), paid to individuals according to the level of the job secured, in addition to the individual's own characteristics. Our empirical analysis is based upon data from a survey that was carried out amongst 18722 graduating students, from 45 universities and colleges in seven provinces spread geographically across China, including 5 higher education institutions in Beijing, 6 in Shangdong, 6 in Guangdong, 6 in Hunan, 4 in Shannxi, 17 in Yunnan and 1 in Guangxi, under the supervision of the Research Centre for the Economics of Education at Peking University. It was carried out in June 2003 in the middle of the period 1997 – 2010 when the expansion rate in the number of students graduating from China's higher education system was at its highest. Within the sample, 39.3 per cent of graduating students had graduated with college diploma qualifications, 57.1 per cent with Bachelor degrees, 3.0 per cent with Master's degrees and 0.6 per cent with Doctorates.

V.1 Graduation wage determinants

In order to allow for the possibility that the job level does affect graduation wages directly, as in Model M2, we consider a graduation lnwage function that may include not only individual characteristics but also a dummy variable for the level of the job secured on graduation. Since unemployment benefits in China are less than one per cent of the wage level of many new graduates, we will maintain our earlier assumption that $\varsigma_t = 0$ in comparing Model M2 with Model M1 through consideration of the graduation lnwage function. The detailed list of individual characteristics and job levels considered is shown in Table II below. The results of applying this formulation to our dataset for China are given in Table III below. Since our graduation wage data are only available for students studying College Diplomas or higher qualifications, the base case chosen is a job at College Diploma level, with the additional dummy variables JLevel2, JLevel3 and JLevel 4 in Table III equal to one if the level of the job is identified as being of Bachelor, Master's or PhD-level respectively, and zero otherwise.

Table II. - DEFINITION OF VARIABLES

Variable	Description
Schooling:	Log (total years spent in higher education) - log(2 years for college study)
Gender:	The dummy variable for gender equals one for females and zero for males
Position of Responsibility: Cadre	The dummy variable equals one if the student has been a student representative at school or university, and zero otherwise
Relationship to Establishment : Partym	The dummy variable equals one if the student is a member of the Communist Party, and zero otherwise
Parental Career: Pcareer	1 = Father is a manager, officer or government official, 2 = Father is a professional technician or clerk, 3 = Father is a manual worker, retailer or a shop assistant, 4 = Father is unemployed, retired or a peasant
Parental Qualification: Pqual	Father's highest qualification is: 1 = a Master's degree or above, 2 = a Bachelor's degree, 3 = a college Diploma, 4 = from senior school, 5 = from junior school, 6 = below junior school level
Place of Birth: Registratn	1= Registered as born in a large city, 2 = Registered as born in a small city, 3 = registered as born in a small town, 4 = Registered as born in a village
English Language: English	1 = Has no College English Language qualification, 2 = Has acquired the College English Test Level 4 qualification, 3 = Has acquired the College English Test Level 6 qualification
University Rank: UnivRank	1 = University belongs to the "985" group of the top 38 universities in China, 2 = University belongs to the rest of the top 100 universities in China, 3 = other universities, with authorization to offer Bachelor degrees, 4 = polytechnic colleges
Degree Classification: DegreeCl	1 = Degree is in the top quartile of marks, 2 = Degree is in the second quartile of marks from the top, 3 = Degree is in the third quartile of marks from the top, 4 = Degree is in the lowest quartile of marks
Major Subject:	The following dummy variables equal one or zero according to whether or not the student majored in the subject contained in the brackets: Philmaj (Philosophy), Econmaj (Economics), Lawmaj (Law), Artmaj (Arts), Scimaj (Science, including Mathematics), Engnmaj (Engineering), Agrmaj (Agriculture), Medmaj (Medicine), Mgtmaj (Management).
Choice of Workplace: Workpl	1 = The job chosen is in a village, 2 = The job chosen is in a small town, 3 = The job chosen is in a small city, 4 = The job chosen is in a large city
Choice of Sector:	The following dummy variables equal one or zero according to whether or not the student chose a job in the sector given in the brackets: Stateown (State-Owned Enterprise), Govern (a Government or related bureau), Jointven (a Joint Venture Company or a foreign company), Institute (an educational institution, such as a research institute or a school)
Choice of Province: WorkPrv	The rank of the province within China in which the job chosen is located from 1 to 31 in decreasing order of its GDP per capita, as an indicator of the current state of its economic development
Job-Level Thresholds:	The hurdle level of the score required secure a job at least at the level shown in brackets: JLevel1 (a college-graduate level job), JLevel2 (a Bachelor-level job), JLevel3 (a Master's-level job), JLevel4 (a PhD-level job)

In Tables III, V and VI below, * denotes that the relevant coefficient is significant at the 90 percent level, ** that it is significant at 95 per cent level, and *** that it is significant at the 99 per cent level. A number of individual characteristics proved to be highly significant in the determination of individual graduation wages. These included the individual's length of schooling, gender, parental career, coming from a larger town or city, and choosing to work in a large city, joint venture and/or more affluent province. In contrast to findings elsewhere (e.g. DOLTON and SILLES [2001]), being female had a significant positive influence on graduation wages. The inverse Mills ratio from our analysis below of the determinants of having a job offer on graduation has a highly significant negative coefficient in the determination of graduation wages, suggesting that those who have additional personality factors which make it more likely that they will have a job on graduation tend to do less well *ceteris paribus* in terms of their graduation wage.

Table III. - DETERMINANTS OF GRADUATION WAGES

Variable:	Schooling	Gender	Cadre	Partym	Pcareer	Registratn	English
Coefficient: **Std error:**	0.018*** 0.002	0.071*** 0.026	-0.045* 0.025	-0.048* 0.028	-0.045*** 0.012	-0.032*** 0.011	-0.043** 0.018
DegreeCl	UnivRank	Philmaj	Econmaj	Lawmaj	Ednmaj	Artmaj	Scimaj
0.030** 0.014	0.010 0.020	0.201 0.157	0.241 0.092	0.154 0.094	0.255 0.205	0.090 0.081	-0.140** 0.080
Engnmaj	Agrmaj	Medmaj	Mgtmaj	Workpl	Stateown	Govt	JtVent
-0.034 0.079	-0.269* 0.110	-0.090 0.101	0.033 0.081	0.051** 0.019	0.023 0.030	-0.087* 0.040	0.219*** 0.043
Institute	WorkPrv	JLevel2	JLevel3	JLevel4	InMillsR	Constant	Wald χ^2_{47}
- 0.022 0.034	-0.018*** 0.001	0.052*** 0.025	0.118*** 0.038	0.095 0.087	-0.484*** 0.082	10.083*** 0.306	1821.98***

However, even after these individual characteristics are taken into account, there is still a highly significant positive impact upon graduation wages of the level of the job which the individual graduate secures on graduation, at least for jobs which are identified as requiring Bachelor or Master's-level skills. For these, we can reject the null hypothesis associated with Model M1 that the job level is not a significant influence upon the graduation wage after taking into account individual characteristics. Model M1, in which wages are no more than are needed to just induce the best n > 0 individuals into the best n jobs, for all for all $0 < n < \eta_t$, is therefore found not to hold for China in its transitional stage of development. Instead, our more general Model M2 in which the job level enters directly into the wage function is found here to have empirical support. Under our assumption of a continuous underlying distribution of job specifications, the mapping of job specifications into a limited number of discrete levels in the determination of graduation wages may result from traditional hierarchical norms and bureaucratic power within its still large public sector, rather than from fully flexible wages within Model M1 under purely market forces. The importance of hierarchical norms within the salary structures of large managerial organisations of the traditional pyramid form has been stressed earlier by SIMON [1957] and LYDALL [1959]. For more specialist posts, namely those requiring PhD-level skills, which are less central to the traditional hierarchy and salary structure of the existing bureaucracy, Table III, however, reveals no such highly significant job level premium.

Further support for the rejection of Model M1 is provided by a firm-level panel data estimation by FLEISHER et al [2011] of the return to education, as measured by difference in the marginal productivity of highly educated workers and less educated workers in China, being on average 30.1 per cent, well in excess of the estimates by HECKMAN and LI [2004] and WANG et al [2009] of the marginal return to additional education through higher wages of 14 – 15 per cent. This tends to confirm the persistence within China's transitional economy of elements of public sector monopsony power and restrictions on labour mobility noted by FLEISHER and WANG [2004] as contributing towards the compression of wages as a function of education and skills, compared to their relationship in the underlying production function. A reduction of wages for more highly educated workers below the competitive level of Model M1 will *ceteris paribus* tend to increase the value of ϑ_{i2} in equation (33) relative to that of ϑ_i in equation (17), and provide an offsetting influence on the extent to which a positive value to ϕ_i in equation (33) under Model M2 encourages a greater desired level of education by individuals than that which would prevail under Model M1.

V.2 Overeducation in China

In this section we will pursue empirically the ordered probit analysis of the determinants of the probability of overeducation, and the associated probability of securing a higher-level job, discussed in Section IV above. Within the literature to date on overeducation, there are three main ways in which overeducation has been measured. The first depends on a systematic external evaluation by an expert job analyst who defines the education requirements of a particular type of job by reference to a standard manual, such as *U.S. Dictionary of Occupational Titles* (e.g. RUMBERGER [1987]) or the ARBI code developed by the Dutch Department of Social Affairs (see HARTOG and OOSTERBEEK [1988]). While this approach seeks to be objective, occupational titles may span different detailed job requirements that can change with technology and economic growth. A second external method is the statistical method developed by VERDUGO and VERDUGO [1989] who define overeducation as existing if an individual has an education level more than one standard deviation above the mean education level for their occupation. However, the mean educational level of those in the occupation will itself depend upon the supply of graduates over time, so that the benchmark for defining overeducation in a particular job is itself endogenous to this process. The third approach, which we deploy here, and which has been widely used elsewhere is that of self-assessment. This method can take account of heterogeneity of individuals and skills needed for each job at the time of the self-assessment. In the survey questionnaire used in our current study, students who had found a job were asked: "What is your current qualification?" (with four possible choices from college diploma to university doctorate) and "What is the minimum formal qualification required in your contracted job?" (with six possible choices from a junior school education to a PhD). Matching the two groups of answers resulted in the distribution for implied rates of over- and undereducation shown in Table IV.

Table IV. - THE INCIDENCE OF OVER- AND UNDEREDUCATION ACROSS EDUCATIONAL LEVELS AND SUBJECTS

Education Level / Subject	Males & Females		Males & Females		Males		Females	
	Per Cent Under-educated	Per Cent Over-educated	Per Cent Male	Per Cent Female	Per Cent Under-educated	Per Cent Over-educated	Per Cent Under-educated	Per Cent Over-educated
Diploma	41.1	12.9	52.7	47.3	41.4	13.5	40.8	12.3
Bachelor	12.4	21.1	65.4	34.6	13.3	21.9	10.7	19.7
Master	7.3	35.8	59.1	41.0	6.4	36.9	8.5	34.1
PhD	0.0	42.0	73.9	26.1	0.0	41.1	0.0	44.4
Total	17.4	20.5	62.8	37.2	17.2	21.5	17.7	18.8
Economics	18.9	22.2	56.4	43.6	18.3	20.6	19.7	24.3
Law	22.0	19.6	49.8	49.8	11.0	6.6	6.2	8.2
Art	18.6	17.1	40.9	59.0	16.9	22.0	19.8	13.7
Medicine	17.2	17.2	44.8	55.1	17.0	12.3	17.4	21.2
Science	12.2	18.3	59.1	41.0	14.4	21.7	9.0	13.4
Engineering	16.8	18.5	78.0	22.1	16.8	19.1	16.7	16.7
Agriculture	8.3	28.1	73.0	26.9	10.0	30.0	3.7	23.0

Table IV shows that overall 20.5 per cent of graduates across China who had jobs reported themselves as being overeducated. This is a higher than the 12 per cent rate of overeducation found by BAUER [2002] in Germany and the 17 per cent rate found in Holland by HARTOG and OOSTERBEEK [1988] and by ALBA-RAMIREZ [1993] in Spain. However, it is considerably lower than the 42 per cent rate found in the UK by BATTU et al [1999], the 30-38 percentage rate found in another study in the UK by DOLTON and VIGNOLES [2000], the 30 per cent rate found in Canada by FRENETTE [2004], and the rates of 42 per cent and 41 per cent in the US found by DUNCAN and HOFFMAN [1981] and SICHERMAN [1991] respectively, with all of these studies using the self-reporting method. The percentage in China, however, varies in Table IV from 12.9 per cent in the case of college graduates to 42.0 per cent in the case of PhDs, with overeducation more frequent among those studying for higher degrees than among those studying for lower degrees. This is consistent with the findings of GROOT [1996] in the UK, although differs from those of FRENETTE [2004] in Canada, where graduates with Master's degrees were the most likely to be overeducated, followed by college graduates.

The overall rate of overeducation for females in Table IV in China is 18.8 per cent, rather less than the overall 21.5 percentage rate for males. The overall rates of undereducation in China for females and males were similar at 17.7 per cent and 17.2 per cent respectively. In comparison, GROOT [1996] in the UK, and DUNCAN and HOFFMAN [1981] in the US, found the overall rates of both overeducation and undereducation to be less for females than males. Our findings across fields of study differ from those in developed countries, where there tends to be a high variation in overeducation rates across fields of study (see FRENETTE [2004]). In China, the overeducated rate is similar across major subjects, with the exception of Agriculture, which has the highest overeducation rate and the lowest undereducation rate. Outside of Agriculture, Economics graduates have the highest overeducation rate and Law graduates the highest undereducation rate. The overall rate of undereducation was 17.4 per cent, and monotonically increased from 0.0 per cent for PhDs up to 41.1 per cent for college Diploma graduates, with a similar trend for both males and females.

In line with equation (29), the determinants of the probability of securing a higher-level job were estimated by an ordered probit model conditioning on their individual characteristics. As our sample is selected from graduates who had already signed their employment contract, who may systematically differ in their individual characteristics from the wider population of graduates, the HECKMAN [1979] two-step method was used to adjust for sample selection. In the first step, a probit model was used to estimate the parameters of the selection equation for those graduates who had been successful in obtaining an employment contract by the time that they were graduating. These parameter estimates were then used to obtain the inverse Mills ratio (DAVIDSON and MCKINNON [2004], p. 488) that was used to correct for selection bias in the second step, where an ordered probit model was used to analyse the variables which influence individual attractiveness for securing a higher-level job and the associated hurdle scores, which in turn determine the overeducation and undereducation rates amongst those who did have job offers on graduation.

The coefficients in the initial probit analyses for the variables which affect the probability of having any job offer on graduation are shown in Table V below. In order to aid the identifiability of the ordered probit model in the second step of the analysis (see VELLA [1998], p. 135), additional variables were included in the initial probit analysis for the probability of having any job offer in the first step. These included ULocatn and BLocatn, which correspond to the rank from 1 to 31 of the GDP per capita within China of the province in which, respectively, the current university of the student is located, and their birthplace is located. They also included English2, which corresponds to the square of the English variable in Table II above, and which adds to the degree of non-linearity involved that can further aid identifiability (*ibid*, p. 135).

Table V. - PROBIT ANALYSIS FOR THE PROBABILITY OF HAVING ANY JOB OFFER BEFORE GRADUATION

Variable:	Schooling	Gender	Cadre	Partym	ULocatn	BLocatn	Pcareer
Coefficient: **Std error:**	0.197*** 0.028	-0.193*** 0.028	-0.151*** 0.027	0.103*** 0.035	-0.034*** 0.002	0.007*** 0.002	-0.040* 0.016
Pqual	Registratn	English	English2	DegreeCl	Philmaj	Econmaj	Lawmaj
-0.016 0.013	0.017 0.013	0.312* 0.164	-0.122*** 0.041	-0.045*** 0.016	-0.386* 0.220	0.136 0.105	-0.353*** 0.103
Ednmaj	Artmaj	Scimaj	Engnmaj	Agrmaj	Medmaj	Mgtmaj	Constant
-0.140 0.144	0.120 0.092	0.106 0.093	0.537*** 0.089	0.110 0.132	0.267** 0.177	0.273*** 0.092	-11.241*** 0.875

The findings in Table V are consistent with the probability of having any job on graduation being the result of conflicting pressures to secure a job before graduation. If the individual can find a job which meets the individual student's expectations, without engaging in excessive search time that may detract from the student's remaining university work, they may seek and accept such a job offer. However, if this condition does not hold, the student may decide not to seek or accept a job offer before graduation that does not meet their longer-term expectation, but instead decide to search harder after graduation when they have more time available to search for a job which does meet their longer-term expectation. The significant negative coefficients on being female in Table V suggest that females have more difficulty in China in securing a job offer before graduation that meets their longer-term expectation. The negative coefficient on English2 but positive coefficient on the English variable suggest that there may indeed be a non-linear inverted U-shaped relationship between English ability (which we confirm below is an important determinant of the level of the job which the student can expect) and the probability of their having a job offer before graduation. Students whose English scores are currently low may decide not to take a lower-level job before graduation, but instead devote their time to improving their academic performance before graduation and more time to searching for a better job after graduation. Those students whose current English scores are reasonably good are more able to secure a good job offer before graduation, and more likely to accept it. Those students whose English abilities are high may be more confident of being able to secure a very good offer after graduation and are less willing to spend time searching for a job offer before graduation rather than concentrating upon their studies.

The significant positive coefficients on the educational qualification variables and on Party membership in Table V, alongside their positive role in boosting the level of job the individual is likely to be offered in Table VI below, indicate that these variables raise the chances of the individual securing a good job that meets their longer-term expectations before graduation. Since the Ulocatn variable involves the ranking of the province in which the university is located according to its GDP per capita from the top of the associated distribution within China, the significant negative coefficient on ULocatn in Table V indicates that a higher GDP per capita for the province in which the university is located tends to boost their chances of receiving an acceptable job offer. Conversely, the significantly positive coefficient on BLocatn is consistent with higher expectations for those students who originate from more affluent provinces, and a lower willingness to accept a job offer before graduation that does not meet their higher expectation. The significant negative coefficient on the Cadre variable in Table V suggest that individuals with greater responsibilities within the university may be less willing to spend time searching for a job before graduation. The significant negative coefficient on the degree classification variable that indicates the quartile from the top in which the individual's marks fall is consistent with a greater willingness of students with good marks to look for a job before graduation. There are also several significant coefficients on degree subject in Table V, in contrast to their absence in Table VI below. Majoring in Engineering, Medicine and Management can significantly increase the chances of a job offer before graduation, whereas majoring in Law tends to reduce it.

The coefficient on the Schooling variable that reflects the length of higher education proved to be highly significant in positively influencing both the chances of having any job offer on graduation in Table V and in boosting the individual's probability of receiving a higher-level job offer in Table VI below. These results confirm the importance of the risk modification terms $\partial p_{i\ell} / \partial T_i$ and the associated value of ϕ_i in equation (33) above that prevails under our Model M2 but not under Model M1.

Table VI. - DETERMINANTS OF THE PROBABILITY OF A JOB OFFER AT DIFFERENT LEVELS

Variable:	Schooling	Gender	Cadre	Partym	Pcareer	Registratn	English
Coefficient: **Std error:**	0.341*** 0.020	-0.002 0.034	0.036 0.026	0.0253*** 0.029	0.005 0.014	0.011 0.019	0.079*** 0.024
DegreeCl	UnivRank	Philmaj	Econmaj	Lawmaj	Ednmaj	Artmaj	Scimaj
0.018 0.012	-0.081** 0.022	-0.042 0.178	-0.090 0.231	-0.076 0.199	-0.055 0.294	- 0.068 0.217	-0.130 0.138
Engnmaj	Agrmaj	Medmaj	Mgtmaj	Workpl	Stateown	Govt	JtVent
0.083 0.189	-0.088 0.178	0.218 0.390	-0.037 0.189	0.191*** 0.061	-0.041 0.028	-0.005 0.104	0.104*** 0.041
Institute	WorkPrv	InMillsR	JLevel1	JLevel2	JLevel3	JLevel4	Wald χ^2_3
0.311*** 0.047	- 0.002 0.003	0.063 0.129	4.362*** 0.474	5.421*** 0.436	7.388*** 0.460	8.628*** 0.507	7.84**

The inverse Mills ratio, however, proved to be insignificant in the ordered probit model in Table VI, so that there is no evidence here of sample selection bias associated with differences in the characteristics of those with, and those without, job offers on graduation. While gender, cadre, parental career and place of Registration are found not to be significant in increasing the probability of a higher-level job on graduation in China, Party membership is found to be a very significant positive factor in Table VI. So too is English language ability and graduation from a top-ranking university. In contrast, degree classification proved to be an insignificant factors in influencing the probability of a higher-level job on graduation in China. This parallels the conclusion of BATTU et al [1999], who found that degree class played no part in explaining overeducation in UK, but is in contrast to the conclusion of DOLTON and SILLES [2001] that students graduating with first class honours in the UK are more likely to find a degree-level job. Its lack of significance in China may reflect the fact that degree programmes in China still contain compulsory courses in Marxism, Chinese History and other subjects which count towards the final degree classification, but which employers do not value highly in their selection of recruits.

The lack of significance of the major subject of the student's degree in China in Table VI contrasts with the findings of GROOT [1996], BATTU et al [1999], DOLTON and SILLES [2001], and FRENETTE [2004], that being a graduate in Arts or Languages in the US, UK or Canada increases the chances of failing to find a graduate-level job. In contrast to the findings of DOLTON and VIGNOLES [2002] that there is a significant wage premium on mathematical ability in the UK, being a graduate in Mathematics in China does not have a significantly positive effect on the chances of securing a graduate-level job. In contrast to the UK, where students may give up studying Mathematics at the age of 16 (or even 14), Mathematics is a compulsory subject for students in China in the entrance examination to higher education at the age of 18, which they must pass at a high level to gain a university place, so that proficiency in Mathematics carries less of a scarcity value in China than in the UK, with no boost to the probability of securing a higher-level job, or indeed in the graduation wages examined Section V.1 above, from graduating in Science or Engineering that may require greater mathematical abilities than graduation in several other subjects. Willingness to take a job in a larger city, in a Joint Venture, or in an educational institute, however, does have a positive impact in Table VI on the probability of securing a higher-level job on graduation. Overall, there are therefore interesting differences in the pattern of individual characteristics which appear to be significant in China in influencing the chances of securing a higher-level job from those found elsewhere.

Moreover, questions arise as to the efficiency of the above selection process of graduates into higher-level jobs. The highly significant factor of Party membership in securing a higher-level job raises questions of the extent to which the coefficient on this variable in the selection process does align with its coefficient in an underlying production function, as Model M1 assumes, or is part of a potentially less aligned selection process, as under our Model M2. If Party membership is itself a reward for leadership and networking skills that may prove beneficial in boosting the value of production in a subsequent job, then it is possible that it does align with its associated marginal productivity. However, it is also possible that it might reflect a desire to maintain a centralised bureaucratic control structure within the economy which may be less conducive to increased production. What is true from a comparison of Tables III and VI is that the coefficients on the individual characteristics in Table III in explaining graduation wages are not constant multiples at any given time of the coefficients on the same individual characteristics in Table VI for the probability of securing a higher level job, in the way that Model M1 and its associated equations (8) and (24) require once $\varsigma_t = 0$.

VI. Socially Optimal Investment in Education

The empirical evidence in Section V above of a high rate of overeducation within the emerging economy of China accords with our theoretical analysis of Section III above, that individuals have an incentive to over-invest in education, compared to the level which maximises the net value of their production. Moreover this incentive is greater when the job level enters directly into the graduation wage equation, with Section V.1 above finding empirical support for this formulation in China. However, in determining the overall efficiency of the apparently high level of overeducation that is associated with China's own recent major expansion of its higher education system, account must be taken of a number of important additional considerations. These in particular arise when we relax our earlier assumption that the growth rates g_θ , g_S, g_T and the coefficient γ_2 are constant over time.

In order to examine the impact of possible changes in these growth rates, we may first note that the mean value of production *per capita* in the economy at each time t is given from equations (1) – (3) by:

$$V_t \equiv E(V_{ijt}) = \theta_t \exp(\mu_{St} + \mu_{Ht} + 0.5(\sigma_S^2 + \sigma_H^2 + 2\rho_{SH}\sigma_S\sigma_H)) \quad (36)$$

using AITCHISON and BROWN ([1963], pp.8, 12). It can be seen from equation (36) that V_t depends in general on the correlation coefficient ρ_{SH} within the economy between the index of job specifications for each job and the index of characteristics of the individuals who fill those jobs. Model M1 secures the maximum mean value of production *per capita* by ensuring that the jobs with the highest specifications, according to the index S_{jt}, go to the individuals with the highest ratings for their relevant skills and education according to the index of individual characteristics H_{it} , so that there is a correlation coefficient of one in (36) between S_{jt} and H_{it} across the economy. However, under Model M2, for which we have found empirical support in China, there is a potentially imperfect correlation between the index S_{jt} of job specifications and the index H_{it} of individual characteristics under the logarithmic weights γ_h , when the selection process deployed instead involves logarithmic weights $\hat{\gamma}_h$ on the individual characteristics that are not necessarily equal to the coefficients γ_h in the underlying production function. Under such an imperfect correlation, the mean value of *per capita* production is less than its potential, implying an inefficient allocation of educated human capital across the economy.

When we take account of the full tuition costs and of the impact of additional years T_i of education not only on each individual's own production, as in equations (20) – (22), but also upon the growth rate g_o in the value of *per capita* production within the economy, we obtain the socially optimal level of education for individual i to be given by:

$$T_i^{***} = \gamma_1 / [\gamma_2 + ((1 + G_i^o - \omega Y_i^0 - \chi_i)(r - g^o) / (1 - Y_i^o))] \tag{37}$$

$$where\ \chi_i \equiv (V_{T_i}\eta_{T_i} / V_{ijT_i})(((\partial g_o / \partial T_i) / (r - g_o)^2) - 1)\ \ and\ g_o \equiv g_\theta + g_S + \gamma_2 + (\gamma_1 - \gamma_2) g_T \tag{38}$$

An increased length of education, not least at the graduate level, may have a positive impa ct on the growth rate g_o, as reflected in the term $(\partial g_o / \partial T_i)$ in equation (38), through increasing each of the above components of g_o. The first of these is the rate of growth, g_θ, of the macroeconomic variables within the index θ_t. This includes the rate of technological progress, which may be increased by a process of endogenous growth (BARRO and SALA-I-MARTIN [1995]), such as through the more rapid rate of diffusion of technology from more advanced economies, as a result of more advanced learning and a greater contact with international bodies of knowledge. The importance of a higher level of education in increasing the speed of adoption of best-practice technology has been emphasised by NELSON and PHELPS [1966], with ACEMOGLU et al [2006] underlining the role of human capital in boosting economic growth both in the adoption of existing frontier technology, and in the innovation of new technology, where advanced learning is likely to be even more important.

In the case of China, there may be great scope for the deployment of graduate-level skills not only in the improved design and manufacture of existing products, and their production at lower environmental cost than has been involved in China's recent rapid economic growth, but also in the innovation of more sophisticated products and services based upon more advanced technology. This in turn may increase the rate of growth of the value of China's exports, domestic consumer expenditure and other components of its GDP. Thus, whilst in the past non-graduate production and supervisory jobs in low-cost manufacturing have helped to generate a substantial trade surplus for China, achieving greater value added in the face of international competition may in the future require more graduate-level skills in design, engineering and management. The deployment of more graduate level skills in the investment of China's very large stock of foreign exchange reserves (that were valued at US $3,305 billion in March 2012) may further boost the rate of growth of its foreign exchange earnings. While these have in the past been invested mainly in fixed interest securities, China is now turning its attention to more active equity investment in overseas enterprises, with a consequent need for more graduate-level investment and management skills.

The above process may be reinforced by a form of *Say's Law*, in which an increased supply of graduates tends to create its own demand, through a steady raising of the job specifications (as reflected in the index S_{jt}) of those jobs into which graduates are recruited, so that they more fully utilise the additional education which they have received. This process may start in response to an initial excess supply of graduates by a raising of the nominal job requirements to include a degree, for many jobs and professions where non-graduates had previously been recruited in large numbers. However, over time, technological progress and an increased sophistication of China's products and services may facilitate, and themselves be facilitated by, an upgrading of the actual skills which graduates exercise in the jobs to which they have been recruited. Overeducation therefore needs to be viewed in this context as a dynamic phenomenon, in which the growth rate, g_S, of job specifications, and the associated process of skill-biased technological change (see MACHIN and MANNING [1997], ACEMOGLU [1998], [2002a], [2002b], and MACHIN [2004]), may themselves be boosted by increased education.

In addition to boosting the growth rate g_o through increases in both g_θ and g_S, increased education may boost the rate, γ_2, of learning-by-doing in equations (1) and (17), by which work experience after an individual's years of formal education helps to boost the value of output. Graduate education may facilitate enhanced learning, problem-solving abilities and adaptability to change that will enable graduate to progress faster and translate experience into more valuable production at a higher rate per unit time.

The above processes will also be reinforced if there exist complementarities between the productivity of individual graduates, as well as complementarities between the productivity of individual graduates and the capital and technology which they deploy. Individual graduates may be better able to deploy their enhanced skills in transactions and collaborations with other graduates, so that there is an externality at work in the impact of an increased length of education for an individual on overall social productivity and economic growth (see EASTERLY [2001]). If an increase in the growth rate, g_T, of the length of education does succeed in boosting the economic growth rate, $g^o = g_\theta + g_S + \gamma_2$, this will itself reinforce the growth rate, g, of wages in equation (17), and thereby to some extent offset the negative partial effect which a higher rate of growth, g_T, in the length of education has on the growth rate, g, of wages and on individuals' desired length of education T_i^* in equations (15) and (17). A higher rate of growth, g_T, in the length of education will further boost g_o in equations (38) whenever the coefficient γ_1 on additional education in the production function (1) exceeds the coefficient γ_2 on additional work experience in equation (1).

All of these influences will tend to increase the marginal impact of additional years' education upon the growth rate g_o in equation (38), thereby boosting the value of χ_i and the socially optimal length of education T_i^{***} in equation (37). Any excess of the individual's desired length of education T_i^* over the socially optimal length of education will then be smaller than otherwise, with overeducation in terms of an excess of T_i^* over T_i^{***} not in general implied. The divergence between the private and social optimums will also be reduced via equation (17) in Model M1 and equations (33) and (34) in Model M2 by a declining real value of graduate starting salaries, rising real wages for those with less education, and significant increases in college tuition fees, such as have occurred in China in recent years (see JACOBS [2010], WANG et al [2009]). Any divergence between the actual length of education and the social optimum can in addition be reduced by tighter non-price admissions criteria for entry into higher education and a restriction on the number of places made available to more closely align with the social optimum.

For Model M1, we have from equation (37) and equation (17):

$$T_i^* (>,=,<) T_i^{***} \ as \ \vartheta_i (<,=,>) \vartheta_i^* \equiv (G_i^o + 1 - \omega\, Y_i^o - \chi_i)\pi_i - (1 - \omega Y_i) \tag{39}$$

$$where\ \pi_i \equiv (1 - Y_i)(r - g^o)(1 + \sigma) / [(1 - Y_i^o)(r - g)] > 0$$

ϑ_i^* is here the socially optimal level of the tuition fee charged to individual i for a year's additional education as a proportion of their foregone wage that will equate the individual's desired length of education to the socially optimal length of their education. The socially optimal level, ϑ_{i2}^*, of the proportional tuition fee when Model M2 prevails in contrast from equations (33) and (37) is such that:

$$T_{i2}^*(>,=,<)T_i^{***} \ as \ \vartheta_{i2}(<,=,>)\vartheta_{i2}^* \equiv (G_i^o + 1 - \omega Y_i^o - \chi_i)\pi_i[(1-Y_{i2})/(1-Y_i)] + \phi_i - (1-\omega Y_{i2}) \qquad (40)$$

Under Model M2, a higher optimal level of the tuition fee is implied here *ceteris paribus* the greater is the value of ϕ_i and the associated impacts, $\partial p_{is} / \partial T_i$, of the length of education on the probability of securing higher-level jobs, in order to counteract the greater incentive for overeducation that may otherwise prevail under Model M2. In particular, when $\omega = 1$, so that additional education results in later retirement and the same length of the working life, we have from equations (12), (17), (33), (39) and (40):

$$\vartheta_i^* = (G_i^o - \xi_i)\pi_i + (1-Y_i)\sigma(r-g^o)/(r-g) \ and \ \vartheta_{i2}^* = \vartheta_i^* + \phi_i \qquad (41)$$

The values of ϑ_i^* and ϑ_{i2}^*, and the extent of any excess of the individual's desired level of education over the social optimum, will again be decreasing functions of the strength of the *marginal impacts* of years of additional education upon the growth rate g_o, as reflected in the magnitude of χ_i in equations (37) – (40). That economic growth may be first an increasing, but then a decreasing, function of the percentage of high-skilled individuals in the population is discussed in REHME [2007]. If a failure of graduates at the margin to find jobs that utilise their additional education is associated with a permanent state of under-employment of their graduate abilities, then doubts may arise as to the numerical strength of these marginal impacts in equations (37) – (40), and hence of the degree to which such individuals' desired lengths of education T_i^* and T_{i2}^* under both Models M1 and M2 are aligned with the socially optimal length of education T_i^{***}. These doubts may be reinforced by mixed empirical evidence on the link between additional educational investment and economic growth (see e.g. MANKIW et al [1992], BENHABIB and SPIEGEL [1994], PRITCHETT [2001], KRUEGER and LINDAHL [2001], and DE LA FUENTE and DONENECH [2006]). The high annual growth rates in new graduates in China revealed in the penultimate column of Table I may then in part be a response to, rather than a cause of, China's growing national income, as reflected in its annual growth rates of its GDP in the last column of Table I. In addition, the achievement of sustained economic growth may depend upon the joint fulfilment of many other conditions than educational expansion (see EASTERLY [2001]), and may itself be compromised by additional risk factors associated with international debt crises.

Nevertheless, China starts from a relatively low percentage of its population in possession of tertiary education, with only 5 per cent of its 25 – 64 year old population having attained tertiary education in 2009, compared to 26 per cent for Germany, 29 per cent for France, 39 per cent for Korea, 37 per cent for the United Kingdom, 38 per cent for the United States and 44 per cent for Japan (OECD [2011]). There may therefore still be great scope for even transitionary gains to China from the diffusion of advanced knowledge and technology from more advanced economies, that the expansion of higher education in China can help to achieve. The importance of the *composition* of the human capital stock in disentangling the impact of higher education on economic growth has been emphasised by AGHION et al [2006], who found some empirical support from US data for their model in which more advanced education maximises productivity growth for those states which are close to the current technological frontier, while less advanced education maximises productivity growth for those states that are far from this frontier. As China seeks to move closer to the international frontiers of technological progress, a substantial input of graduate-level skills may in particular be required if it seeks to develop its own *output-mix* beyond the mass production of low technology products into those based upon more advanced electronics, engineering, science and design.

At the same time, less advanced education may be needed in other directions where the existing distance from the knowledge frontier is even greater. As in Table IV above, we found overall a 17.4 percentage rate of self-reported undereducation amongst graduating students across China, that was concentrated particularly amongst students graduating with only a two-year College Diploma, where the rate of undereducation rises to 41.1 per cent. This suggests considerable scope for beneficial additional education within this part of the higher education sector in China, particularly in its vocational relevance. It is notable elsewhere that in contrast to the substantial increases noted in Section I above for the OECD over the period 1995 – 2009 in entry rates and graduation rates for Tertiary-type 5A degree programmes with a mainly theoretical content, over the same period for the mainly practical and vocational Tertiary-type 5B programmes the entry rate only rose from 17 per cent to 19 per cent and the graduation rate actually fell from 11 per cent to 9 per cent of the relevant age group within the OECD (OECD [2011]). As HECKMAN [2005] notes, China's rapid expansion of its physical investment in more advanced capital equipment needs more skilled workers to operate it, to complement the unskilled workers who have migrated *en masse* into urban areas, and to address the regional imbalances which have developed in economic growth rates across China. However, the skills which are able to achieve these objectives are arguably mainly applied industrial ones, including those of blue-collar workers, rather than the ones that are typically developed by many existing Tertiary-type 5A degree programmes.

VII. Conclusion

Even when additional education increases production, an efficient alignment of the private and socially optimal lengths of education is not guaranteed when wages flexibly adjust to competitive supply and demand conditions in the labour market, as under Model M1 above. When wages are linked also to more rigid administrative classifications of job level, as under our Model M2, additional considerations of risk and uncertainty arise for individuals investing in education, in the absence of forward contracts for their labour. The extent of any divergence between the private and socially optimal lengths of education under both Models M1 and M2 depends upon the interaction of a number of important factors discussed above, and whose values are themselves subject to change and uncertainty. The recent rapid expansion of the higher education system of the major emerging economy of China highlights the importance of these interactions.

The effectiveness with which China deploys its rapidly expanding graduate population, following the increase in its gross enrolment ratio for Tertiary-type A and B education from 7 per cent in 1999 to 26 per cent in 2010, and a resultant total annual production of over 7.8 million graduating students (UNESCO [2012]), will have implications not only for China but also for other economies with which China is competing in world markets. Particularly once it moves beyond the mass production of low cost, low technology products, China may have greater scope than many of its competitors for combining increased technological knowledge with relatively low cost labour supplies in the production of more sophisticated products and services. The pressure of increased international competition and globalisation in these product markets may in turn make the returns to investment in higher education in the US and other advanced economies more interdependent with the development of China’s own graduate market, and with the underlying factors which influence the supply and demand interactions for its expanding graduate population.

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